AUTOMATIC DETECTION TEMPERATURE TRANSMITTER FOR CALIBRATION PROCESS USING THERMOCOUPLE

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ABSTRACT

The purpose of this project is to detect temperature for calibration process using type K thermocouple automatically. This project will be implementing using Visual Basic 2008 software to develop Graphic User Interface (GUI). The Type K thermocouple will be use as temperature sensor in calibration process. The implementation of proportional–integral–derivative controller (PID controller) will be monitor the automatic temperature set point and detection system. The Data Acquisition (DAQ) card will be use for interfacing process is to implementation of an automatic detection system for temperature measuring during calibration process. The accuracy of the measurement will be monitor besides the analysis of uncertainty and confidence limit.

ABSTRAK

Projek ini bertujuan untuk mengesan suhu untuk proses kalibrasi dengan menggunakan *thermocouple* jenis K secara automatik. Projek ini akan menggunakan Visual Basic 2008 iaitu perisian untuk membangunkan Grafik Pengguna Antaramuka (APK). *thermocople* jenis K akan digunakan sebagai pengesan suhu dalam proses kalibrasi. Penerapan kawalan PID *(proportional–integral–derivative controller)* akan memantau titik permulaan suhu automatik dan sistem pengesanan. Kad Pengambilalihan Data (DAQ) akan digunakan untuk prosess antaramuka bagi pelaksanaan sistem pengesanan automatik untuk mengukur suhu semasa proses kalibrasi. Ketepatan pengukuran akan dipantau selain analisis ketidakpastian dan had keyakinan.

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LIST OF ABBREVIATIONS

DAQ	Data Acquisition
VB	Microsoft visual Basic software
USB	Universal Serial Bus
GUI	Graphical User Interface
HART	Highway Addressable Remote Transducer
PID	Proportional-Integral-Derivative
Ni	Nickel
Pt	Platinum
Ge	Germanium
PV	Process Variable
LRV	Lower Range Value
URV	Upper Range Value
AGND	Analog Ground
AI0	Analog Input
LED	Light Emitting Diode
V	Volts
℃	Celsius
Ma	mili-ampere
IDE	Integrated Development Environment

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Development of computer-based instrumentation system is an important as so far there are no mechanisms incorporated in software offered that allows instrument to be tailed to individual (researchers, industrial engineers) needs. No measurement is ever guaranteed to be perfect. In many cases results of temperature measurements have to be presented together with the uncertainty of these measurements. It concerns mainly the measurements performed by companies or organisations which have introduced quality management systems consistent with requirements of the ISO 9000 and EN 45000 series of standards and the higher numbers of these standards [3]. Uncertainty of measurement is the doubt that exists about the result of any measurement. By quantifying the possible spread of measurements, the confident of the result can be determined. The uncertainty derives from the measuring device and from the skill of the person doing the measuring.

Currently, the standard limit of error for most thermocouples in industrial measurements is 0.75% with special limits of error at 0.4% across the range. Since most competent labs can calibrate with an uncertainty of better than 1°C, the typical temperature measurement can be vastly improved by utilizing information from a custom calibration. This custom characterization is stored in the memory module and utilized by the data conversion system.

Nowadays, the major change occurring at the present is the increasing number of user friendly software that make it possible for user to experience new and fast ways of learning. In minutes, simulation, controller and real world interfacing can be created instantly. In this project, the software is developed to help user to learn and explore the calibration and uncertainty process with an interesting and interactive way in order to reduce the human error. Besides that, the temperature measurement calibration will consume a long process compared to pressure measurement calibration due to measurement repeatability and therefore, it needs the monitoring of the operator until the process is finish. Therefore, the automatic detection temperature measurement from the temperature source using the Type K thermocouple is proposed in this project. The computer software is menu-based to give the user flexibility and ease of use. The user needs no programming experience to operate the systems.

1.2 OBJECTIVE

The objectives of this project are to

I. To design an automatic detection of temperature measurement in the software from the temperature source port within the range of the setting temperature.

II. To develop software application to help in student learning process. Visual Basic 2008 Express Edition will be use as main programming language. The software is developed to be interactive and friendly user.

III. To interface the temperature transmitter output using thermocouple to Visual Basic application. This interfacing between instrument and computer will be done by using data acquisition (DAQ) card.

1.3 SCOPE

This project is to develop software application to help in student learning process. Visual Basic (VB) 2008 Express Edition will be used as a main programming language. The software is developed to be interactive and user friendly for student. The software that will be includes the calculation for uncertainty and confidence limits for temperature measurement.

Temperature transmitter output will be interface to visual basic software by using Data Acquisition process (DAQ). Advantech USB-4716 DAQ card will be used to interface between instrument and computer.

The automatic detection of temperature measurement will be design in the software from the temperature source port within the range of the setting temperature. All the complete set of the temperature readings will be used directly for the calibration and uncertainty calculation process.

1.4 RESEARCH METHODOLOGY

There are several research methodologies that need to follow:

i. Understand the concept of temperature measurement and indentify the correct method to do the measurement.
ii. Set up the instrument with several reference instruments such as HART, recorder and transmitter.
iii. Understand the method on how to communicate between computer and instrument.
iv. Design and writing the program based on supervisor's opinion.
v. Interface software to thermocouple via DAQ card.
vi. Test the software and compare the result with measurement recorder and temperature transmitter

Design step of work methodology can be simplified as shown in figure 1.1.

Flow chart:

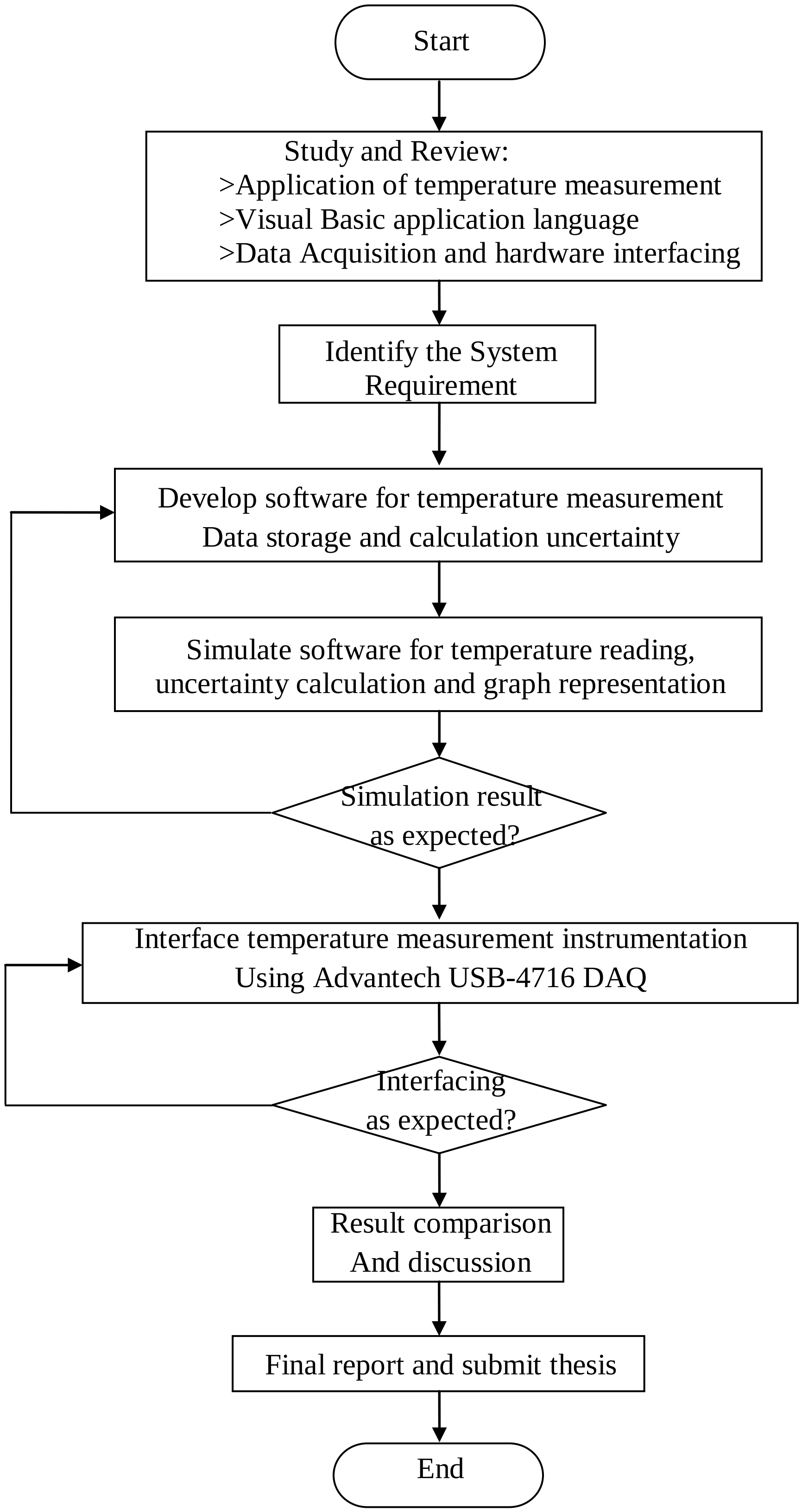

Figure 1.1: Research flowcharts

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

For this project, there are some previous researches that are used to be referred to develop an automatic temperature measurement. These are researches and journals are related to this project either directly or indirectly.

2.2 TYPE K THERMOCOUPLE SENSOR

Thermocouples, as in figure 2.1, contain two electrical conductors made of different materials which are connected at one end. The end of the conductors which will be exposed to the process temperature is called the measurement junction. The point at which the thermocouple conductors end which is usually where the conductors connect to the measurement device is called the reference junction.

When the measurement and reference junctions of a thermocouple are at different temperatures, a millivolt potential is formed within the conductors. Knowing the type of thermocouple used, the magnitude of the millivolt potential within the thermocouple, and the temperature of the reference junction allows the user to determine the temperature at the measurement junction.

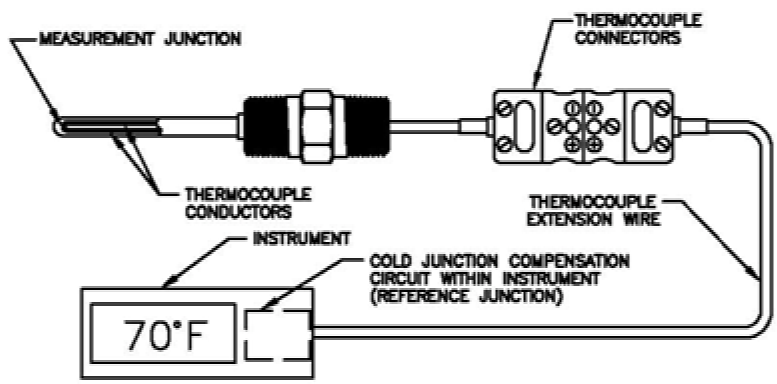

Figure 2.1: Thermocouple sensor constructions

The millivolt potential that is created in the thermocouple conductors differs depending on the materials used. Some materials make better thermocouples than others because the millivolt potentials created by these materials are more repeatable and well established. These thermocouples have been given specific type designations such as Type E, J, K, N, T, B, R and S. The differences between these thermocouple types will be explained in table 2.1.

Table 2.1: Thermocouple types and normal range

Type	Material	Range
E	Chromel/Constantan	0 To 340C
J	Iron/Constantan	−40 to +750 °C
K	Chromel/Alumel	−270 °C to +1372 °C
N	Nicrosil/Nisil	(293 To 1260C
T	Copper/Constantan	−200 to 350 °C
B	Platinum/Platinum-30% Rhodium	800 To 1700C
R	Platinum/Platinum-13% Rhodium	0 To 600C 600 To 1450C
S	Platinum/Platinum-10% Rhodium	0 To 600C 600 To 1450C

The paperwork titled Smart Thermocouple system for Industrial Temperature Measurement by Bill schuh and Watlow create thermocouple with integral memory, complementary instrumentation and software algorithms. The information data stored in the memory of the sensor allow for enhanced measurements by improving the traceability, calibration uncertainty and robustness. While various features of this smart system have been utilized in other temperature measurement systems these have not taken full advantage of sensor knowledge in conjunction with application to provide an industrial temperature measurement [4].

The other paperwork is Temperature Measurement System Based on Thermocouple with Controlled Temperature Field. This sensor uses known method of rejection of systematic error or stabilization on influence factor. In this case it is proposed to make stabilization of temperature field along electrodes of thermocouple. Including several additional temperature control subsystems provides this stabilization during exploitation. Each such subsystem includes additional thermocouple and heater. These additional thermocouple and heater are shifted along the main axis of main thermocouple.

It provides stabilization of this form during testing and during exploitation independently of changing of temperature field of measurement object [5].

2.3 DATA AQUISITION

The purpose of data acquisition is to measure an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound. Figure 2.2 shows data acquisition system typically involves the conversion of analog waveforms into digital values for processing. The components of data acquisition systems include:

- Sensors that convert physical parameters to electrical signals.
- Signal conditioning circuitry to convert sensor signals into a form that can be converted to digital values.
- Analog-to-digital converters, which convert conditioned sensor signals to digital values.
- Data acquisition applications are controlled by software programs developed using various general purpose programming languages such as BASIC, C, FORTRAN, Java, Lisp, and Pascal. COMEDI is an open source API (application program Interface) used by applications to access and controls the data acquisition hardware.

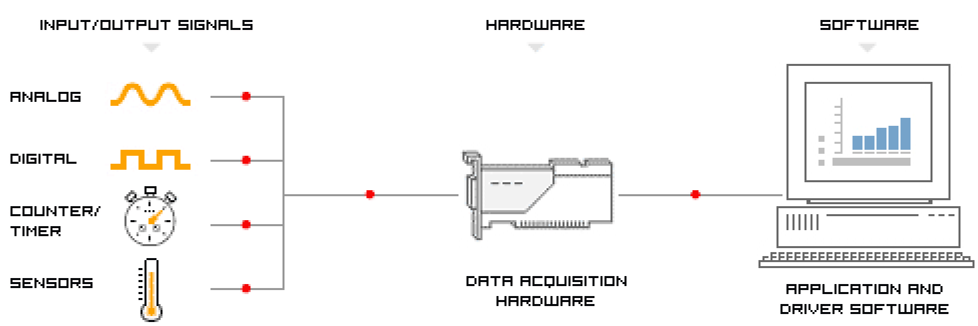

Figure 2.2**:** Data Acquisition connections